

# ENERGY STORAGE

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# VALUES AND APPLICATIONS

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IMRE GYUK, PROGRAM MANAGER  
ENERGY STORAGE RESEARCH, DOE

**On August 14, 2003 the Lights  
went out in much of the  
Midwest and Northeast**

<b>Date</b>	<b>Location</b>	<b>Affected</b>	<b>MW</b>
Nov. 65	NY CT MA RI ONT	30 M	20,000 / 13 hrs
July 77	NY CITY	9 M	6,000 / 26 hrs
Dec. 82	West Coast	5 M	12,350
July 96	West Coast	2 M	11,850 / min-hrs
Aug. 96	West Coast	7.5 M	28,000 / min - 9 hrs
June 98	Upper Midwest	152,000	950 / 19 hrs
Aug. 03	MidW NE ONT	50 M	61,800 / 4 days

**Any Stressed Un-buffered  
Non-linear System is Highly  
Susceptible to Collapse !**

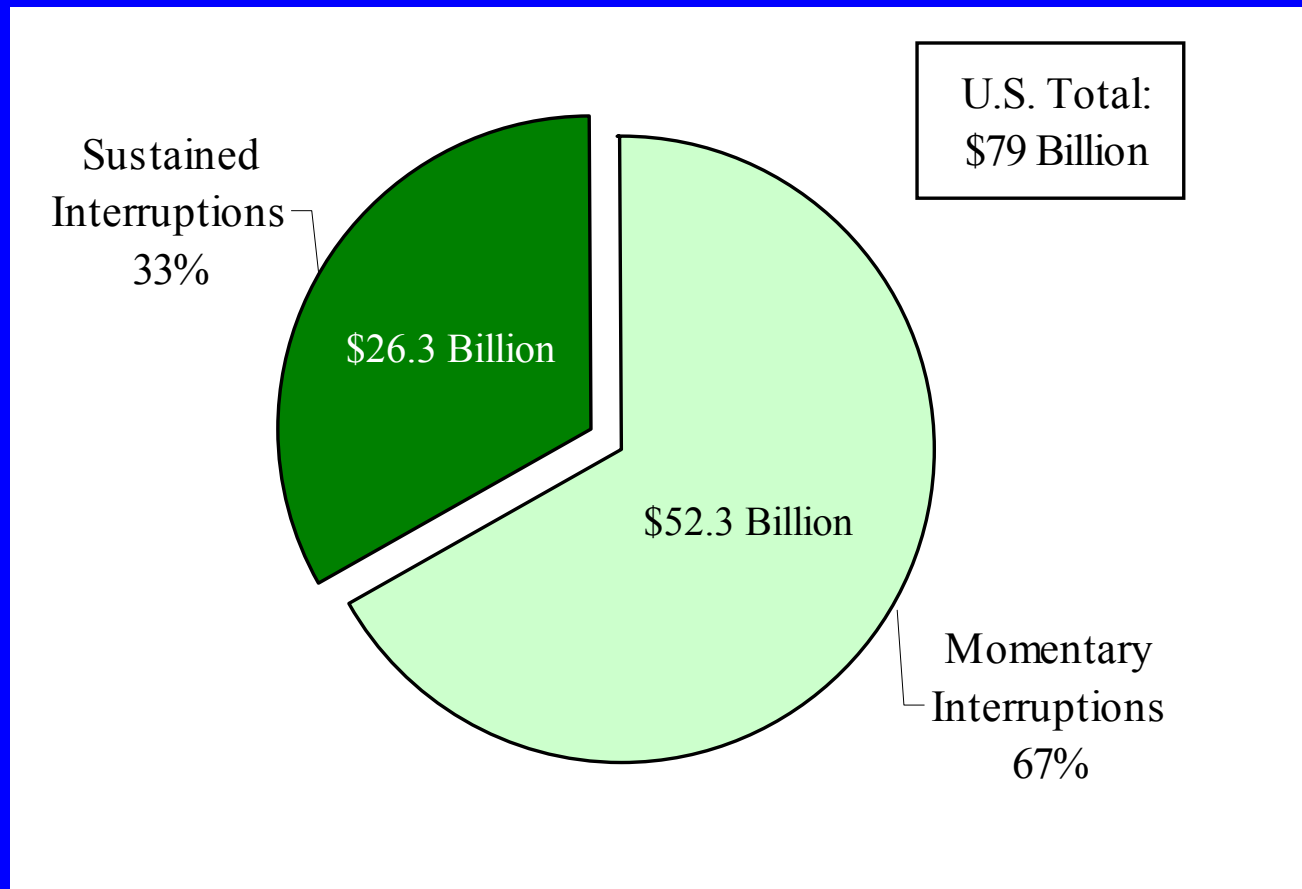
# Stored vs. Delivered Energy:

- 2.5% U.S
- 10% Europe
- 15% Japan

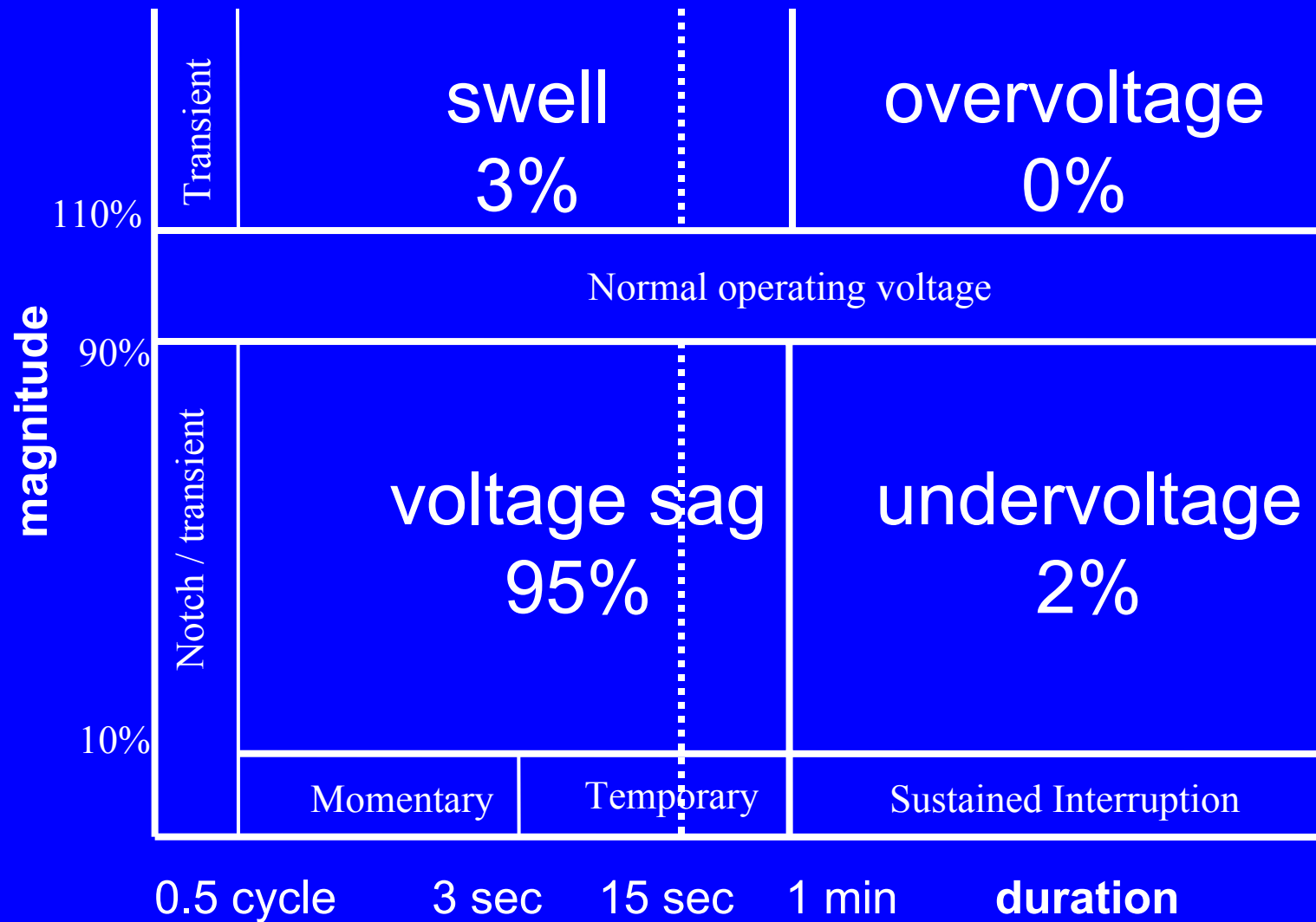
**Outage Costs for U.S. Industry  
estimated at  
\$79 Billion Annually  
in a recent study by Joe Eto, LBL**

**Total Cost of Electricity  
\$250 Billion Annually**

# Momentary Interruptions (<5min) are More Costly than Sustained Interruptions



Joe Eto  
LBL



# Distribution of Voltage Problems



**Momentary Outages of only  
a few Cycles or Minutes  
can lead to  
Hours of Downtime**

**Only Energy Storage**

**can provide**

**Seamless Continuity**

**of Power Supply**

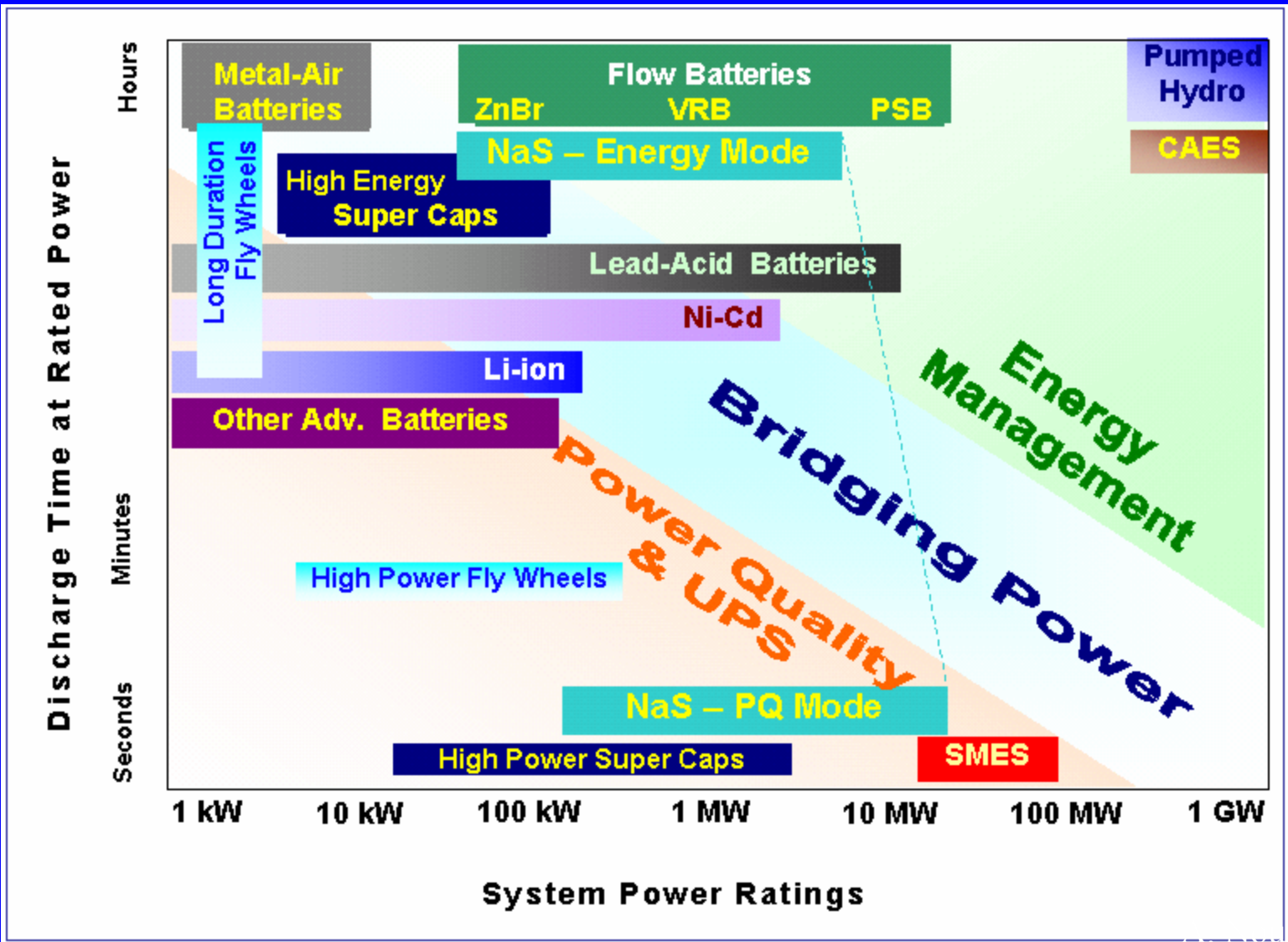
**Energy Storage provides both**

**Real (MW) Power and**

**Reactive (MVAR) Power**

**locally**

# Storage Technologies for Potential Application in California



**Energy Storage**

**protects the Consumer**

**and Stabilizes the Grid**

***POWER***  
**Seconds**

**minutes – hours**

***ENERGY***  
**diurnal**

***LOAD***

**PQ,  
Digital  
Reliability**

**DER Support for  
Load Following**

**Peak Shaving  
to Avoid  
Demand Charges**

***GRID***

**Voltage  
Support,  
Transients**

**Dispatchability  
for Renewables,  
Micro Grids**

**Mitigation of  
Transm. Congest.  
Spinning Reserve**

**ENERGY STORAGE APPLICATIONS**

# Power Quality for a Microchip Plant



10 MW / 15 sec    Lead - Acid System in Arizona

# Voltage Regulation and VAR Support for Golden Valley, Alaska Utility



27 MW / 14 MWh NiCd Batteries – 10MVAR at Rest!



# Integration of Energy Storage, Loads, Wind, Hydro, and Engine Generation for a Palmdale, CA Water Treatment Plan Microgrid

## GENERATION:

- 950 kW Wind Turbine (Average!)
- 2 x 225 kW Energy Bridge Ultracaps
- 800 kW + 350kW Backup Diesel
- 250 kW Natural Gas Backup Generator
- 244 kW Hydroelectric Generator

## LOAD:

- 320 kW Critical Load
- 930 kW Non-critical Load



A Project of the CEC / DOE Energy Storage Initiative

# Peak Load Management for a Japanese Resort Town



**6 MW / 8hrs    Sodium-Sulfur Batteries at Ohito**

# Spinning Reserve and Transient Management for the Puerto Rico Island Grid



20 MW / 14 MWh      New: 10MW Tubular L / A Batteries

# STATE INITIATIVES:

## CEC / DOE:

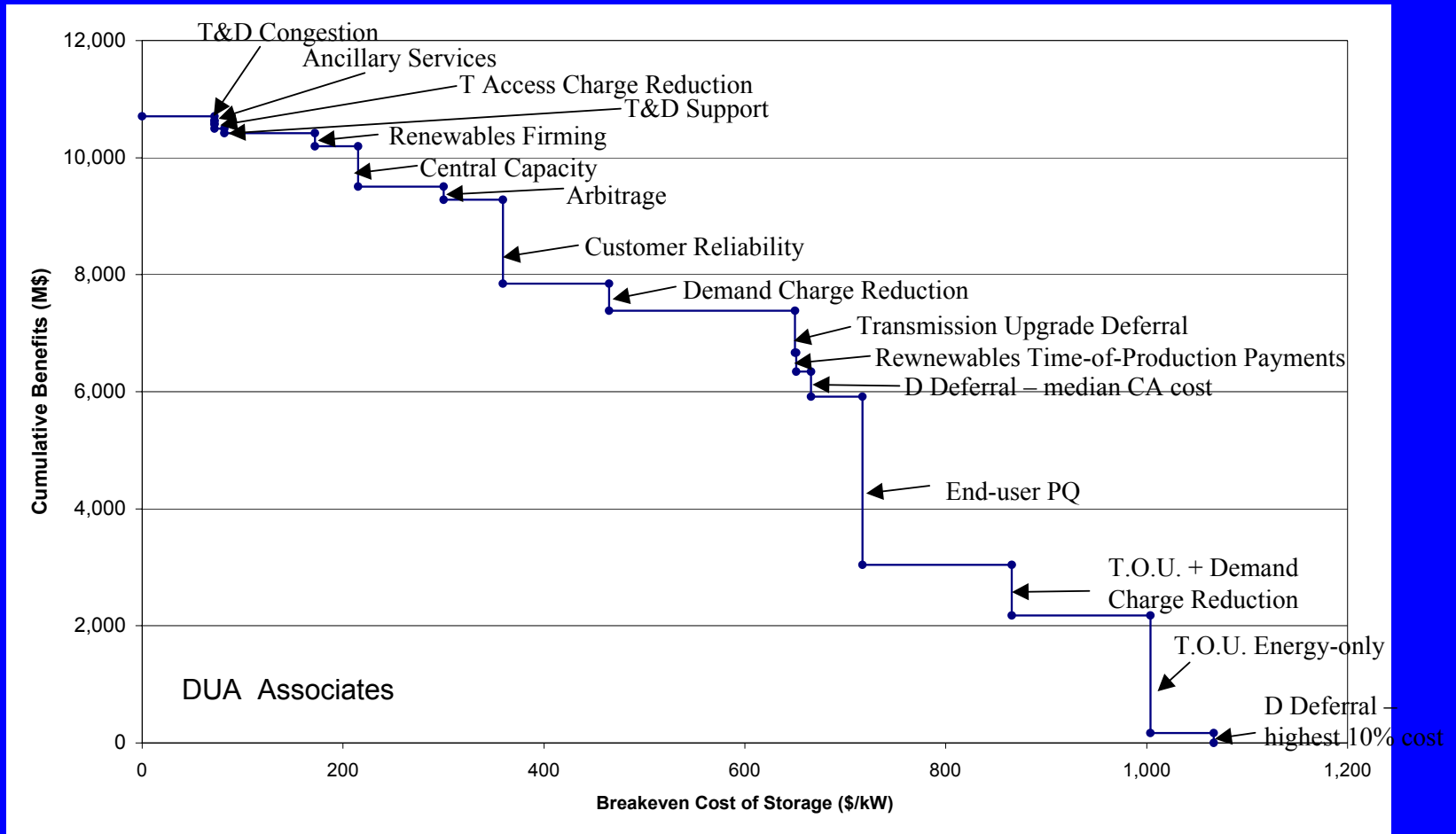
- ZnBr for Substation Congestion Management (PG&E)
- Flywheels for Frequency Regulation (CAISO, PG&E)
- Supercaps for Microgrid Wind Support (Palmdale Water Distr.)

## NYSERDA / DOE:

- NaS for Large Consumer Load Shifting (LIPA)
- Flywheels for Frequency Regulation and Consumer PQ

Details in IEEE Power & Energy Magazine, March 2005

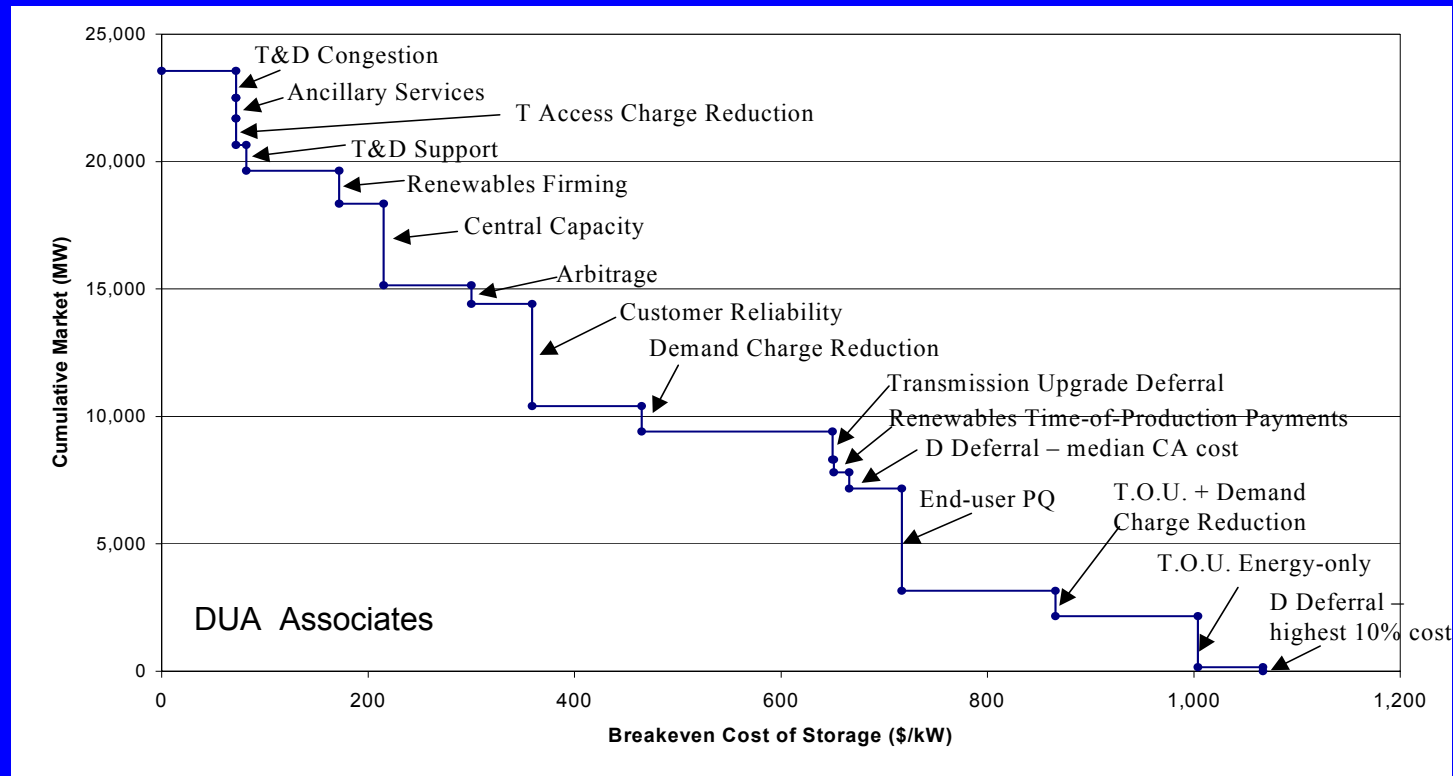
# Storage Benefits, California



**U.S. = 8 x CA**

**single benefit!**

# Storage Potential, California



U.S. = 8 x CA

single benefit!

# CONCLUSIONS:

- Energy Storage has an Essential Role in a Modernized, more Stable Grid
- Storage Technology is developing more Options and more potential Applications
- The Importance of Storage is becoming increasingly Accepted

# Energy Storage Meetings:

- ESA Annual Meeting  
May 23-25, 2005 Toronto  
<http://www.electricitystorage.org>
- EESAT 2005 (Electric Energy Storage Applications and Technology)  
October 17 – 19, 2005 San Francisco  
<http://www.sandia.gov/eesat>



# Contacts and Resources:

- Sandia National Laboratories (Boyes)  
Report Archives, News, Solicitations:  
<http://www.sandia.gov/ess>
- EPRI / DOE Handbook
- EPRI Storage Task Force (Schainker, Eckroad)